



ANNUAL REPORT

OF

THE VETERINARY DEPARTMENT.

SUDAN GOVERNMENT.

1925.



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STAFF.

In consequence of a decision by the Army Council to reduce the number of British Army Veterinary Officers seconded for service in the Sudan the organization of a Civil Veterinary Department became necessary and the post of Director was filled by the appointment of Mr. W. Kennedy, D.S.O., formerly Chief Veterinary Officer, Kenya Colony, on September 9th, 1924.

During the year Captain R. S. Audas, M.C., was appointed Assistant Director and the following Officers resigned their Commissions in the British Army and accepted appointments as Veterinary Inspectors :—Captain J. Going, Captain C. P. Fisher, Captain H. B. Williams, O.B.E., and Captain T. Menzies.

Mr. S. C. J. Bennett, M.R.C.V.S., B.Sc., was appointed Assistant Veterinary Research Officer on September 18th, 1925.

In addition to the above the following British Army Veterinary Officers, seconded to the Sudan Defence Force, hold the appointments shown against their names :—

Major E. G. Turner, D.S.O.	...	Veterinary Inspector.
„ J. R. Ellison	... ..	„ „
„ R. H. Knowles	... ..	Veterinary Research Officer
Captain P. S. Sparling	... ..	Veterinary Inspector.
„ R. T. Smith	... ..	„ „
„ L. E. Prichard, O.B.E.	... ..	„ „
„ F. J. Andrews B. Sc.	... ..	„ „

Veterinary Inspectors were stationed at Wadi Halfa, Khartoum, Wad Medani and El Obeid throughout the year and at Kassala, Port Sudan and El Fasher during the greater part of the year.

Short tours of inspection were made by Veterinary Inspectors in the Upper Nile and Nuba Mountains Provinces and one Veterinary Inspector spent nearly two months at Gallabat purchasing Abyssinian mules for the Government.

Berber Province received little veterinary attention owing to the fact that much of the time of the Veterinary Inspector, who is normally stationed at Shendi, was occupied in purchasing camels for the Government.

The Veterinary Research Officer paid a visit to Eritrea in March to enquire into the method adopted by the Italian Veterinary Authorities in the production of anti-rinderpest serum.

During the year tours of inspection in the White Nile and Kassala Provinces were made by the Director, who also visited Wadi Halfa, Port Sudan, Wad Medani, Shendi and El Obeid.

SECTION I.

DISEASES OF ANIMALS.

The main object of a State veterinary organisation is to reduce losses amongst livestock from disease to a minimum. The methods by which this object may be attained must vary considerably in each country according to its geographical position, its physical characters and boundaries, the nature of the prevalent diseases and the character of the inhabitants.

It will be readily apparent that the system of disease control adopted in a country such as Great Britain, highly civilized and uniquely situated geographically, will differ widely from that applicable to a vast African territory such as the Sudan, possessing land boundaries of over 4,000 miles in length and whose prevalent diseases are common to most of the adjoining territories. In a lesser degree the various African territories differ from one another, each having its own peculiar conditions, so that their disease control problems have to be solved on more or less independent lines.

The essentials of disease control may be described briefly as the discovery of outbreaks in their very earliest stages, the prompt adoption of measures to localize the disease to as small an area as possible and the application of the best available methods for its suppression.

In order to be in a position to exercise this control the veterinary organization must include a thoroughly trained staff of veterinarians, with a good intelligence system, and a laboratory for the preparation of the sera and vaccines required to combat the various diseases. It is also essential that the veterinary staff of each Province should be thoroughly acquainted with the local conditions such as the habits of the stock-owners—nomadic or otherwise—the grazing and water conditions in the various localities at different seasons of the year and the distribution of the tsetse or other blood-sucking flies and ticks. Attempts have been made in the past to collect the required data and place it on record but, owing to lack of staff, the effort could not be sustained. It has only been possible to carry out one or two veterinary surveys of this nature during the year but it is hoped that opportunity will permit of more being done in this important direction in the future. The reports so far received reflect great credit on the officers responsible for them.

When an outbreak of a contagious or infectious disease occurs, the responsibility of reporting it and of segregating the sick from the healthy animals, according to law, rests with the owner but, in the majority of cases, mainly owing to ignorance of the nature of the disease, the necessary action is so long delayed that the outbreak has assumed widespread dimensions before its existence is brought to notice.

A few enlightened Chiefs, such as the Nazir of the Messeria, now adopt effective quarantine measures on the first appearance of any disease in their areas but some considerable time must elapse before the others have been educated up to this point.

It is therefore essential that a well trained native staff be available to act as veterinary intelligence agents and to take prompt action in the event of an outbreak of disease coming under notice.

The Veterinary Police Force as at present organized is a very useful unit but, in many of the Provinces, the staff available is inadequate to carry out efficiently the duties demanded of it. It is proposed to increase this Force in the near future and to establish a training depot at Headquarters where the men will be given courses of training in veterinary work as and when opportunity offers. The fact that these men wear police uniform appears to be of great assistance to them in the execution of their duties.

The functions of the Veterinary Laboratory as at present organized are to assist in the diagnosis of obscure diseases, to produce, as far as possible, the sera and vaccines required for the suppression of outbreaks and to carry out research work on the most important diseases with a view to devising more effective methods of dealing with them. This work has been ably carried out by the Laboratory staff during the year and considerable progress has been made in many directions full details of which will be found in the appended report of the Veterinary Research Officer. Every effort is being made to keep in close touch with the work of other Veterinary Laboratories in Africa and elsewhere in order that mutual benefit may accrue from any important discoveries recorded.

In order to obtain more accurate returns of the causes of mortality amongst animals belonging to Government officials and employees and for which compensation is payable, a pamphlet, giving directions for the preparation of blood smears for microscopical examination was prepared and circulated in all the Provinces with a request that, in future, blood smears from all animals which die should be made and forwarded to the Veterinary Laboratory for examination and report.

I. DISEASES OF CATTLE.

The principal diseases of cattle encountered during the period under review were rinderpest, contagious bovine pleuro-pneumonia, foot-and-mouth disease and anthrax. The relative importance of these may be estimated from the following:—the total number of cases of contagious bovine pleuro-pneumonia reported in the Provinces during the year only amounted to twelve per cent. of the total number of cases of rinderpest, no mortality from foot-and-mouth disease was recorded and, outside the various quarantine stations, only one outbreak of anthrax was reported.

Rinderpest.

Rinderpest is a disease of comparatively recent introduction to the Sudan. According to the records available, Africa, with the exception of Lower Egypt, was free from rinderpest until 1889 when the disease was introduced to Italian Somaliland by a military expedition. As a result of subsequent military operations, Abyssinia became infected in the following year and the disease rapidly spread from there, in a southerly and south-westerly direction, to British East

Africa and Uganda in 1891 and reached the Transvaal in 1896. It does not appear to have entered the Northern Sudan until 1899, but it is highly probable that portions of the Upper Nile and Mongalla Provinces were involved in the southward spread of the disease in 1891. The outbreaks which occurred in the Kassala Province in 1899, and which were thought to have resulted from the importation of cattle from Abyssinia, were promptly dealt with and between 1901 and 1904 the country was believed to be free from the disease. In 1904 it spread from Abyssinia to Eritrea and, soon afterwards, outbreaks occurred in the Red Sea and Kassala Provinces and later in Berber Province, as a result of the movement of infected cattle from Kassala. About the same time the disease spread down the Sobat river involving most of the Upper Nile Province and in 1907 it reached Abyad (Nuba Mountains Province) and invaded Kordofan. During the next five years it appears to have spread throughout the country. It is surprising that the principal cattle areas of the Sudan escaped the epizootic between 1890 and 1899 and this can only be accounted for by the fact that, in the Khalifa's time, no movement of cattle took place from Abyssinia.

At the present time no Province in the Sudan, with the possible exception of Dongola, can be said to be free from the disease.

When rinderpest first appeared about sixty per cent. of the cattle population was killed off but the present position is that most of the adult cattle have passed through an attack of the disease and, in consequence, are immune so that if an outbreak occurs the mortality is chiefly confined to the young stock. Although the returns received from the various Provinces are by no means complete they serve as an indication of what is happening throughout the country, and according to them between ten and twenty per cent. of the total cattle in infected herds are susceptible and the mortality amongst these varies from forty to sixty per cent. If a herd escapes infection for a period of four or five years the percentage of susceptible cattle is, of course, comparatively high. The number of deaths reported from nine Provinces this year amounted to 3,757 as compared with 6,469 in the previous year and the number of cattle serumized was 9,677 as against 12,953 last year.

If an outbreak of rinderpest is detected in the early stages it can be confined to the herd in which it first appeared provided effective quarantine measures can be adopted, that is, provided it is possible to allot a definite grazing area and watering place to the sick herd and to prevent all healthy herds from entering this infected area. By the adoption of these measures only, losses will be confined to the infected herd but these may be serious from the owner's point of view and, in order to reduce them to a minimum, all susceptible cattle which have not developed symptoms of the disease should be given adequate doses of anti-rinderpest serum, if a supply of same is available, and placed in contact with the infected animals so that they may contract a mild attack of the disease. This is the method generally adopted for the suppression of outbreaks in this country.

The injection of anti-rinderpest serum can be carried out by any trained veterinary policeman as it is a very simple operation and the supervision of a Veterinary Inspector, although desirable, is not essential.

Should it be impossible to isolate the infected herd effectively as may be the case in the dry season when cattle concentrate in large numbers on the available wells and watering places, all the cattle using a particular well or meshra must be considered as infected and every effort has to be made to prevent contact between them and healthy herds—by no means an easy task when grazing is scarce and the cattle are consequently grazing over a large area.

It will be evident, therefore, that when an outbreak occurs at a favourable season of the year, when grazing and water is plentiful, it can be confined to a small number of cattle with correspondingly small losses whereas, in the dry season, an outbreak tends to become widespread and, owing to the scanty grazing and the hardship suffered in making long marches between water and the grazing area, the mortality is high.

Double inoculations, that is, the simultaneous injection of suitable doses of virulent rinderpest blood and of carefully regulated doses of anti-rinderpest serum, were carried out in the Berber and Kassala Provinces in 1904 when upwards of 8,000 head of cattle were dealt with. Under certain conditions this method of inoculation gives excellent results but, if it is to be carried out properly, it is considered that its application can only be a very limited one in this country.

In Eritrea, where the grazing and water conditions are much more favourable than in this country for the successful prosecution of a campaign of double inoculation, the Government has decided to double inoculate every bovine in the territory. During the last twelve years a million cattle have been treated in this way and the average losses from inoculation are reported to have been three and a half per cent. In individual cases, however, the losses have been as high as thirty per cent. and, in view of similar experiments in other parts of Africa, one is not inclined to embark lightly on a double inoculation campaign of an extensive nature without proper facilities and an adequate and thoroughly trained staff.

The serum requirements of the Department were obtained from Egypt during the year and experiments were undertaken to ascertain what difficulties if any had to be overcome before serum could be produced locally. The results of these experiments were very satisfactory but, although the cost of production is estimated to be much below the price at present charged by the Egyptian Veterinary Authorities, it was later found that the Eritrean Government could supply the quantities required at a still lower figure owing, chiefly, to the better climatic conditions obtaining in Eritrea and the comparatively low cost of maintaining the cattle used for serum production. It has therefore been decided to obtain the serum required for the next year from Eritrea but, at the same time, it is considered not desirable to rely entirely on extraneous sources of supply and experiments in anti-rinderpest serum production will be continued from time to time so that the Departmental requirements could be produced locally, without undue delay, in the event of any crisis arising.

Contagious Bovine Pleuro-Pneumonia.

The earliest history of contagious bovine pleuro-pneumonia obtainable in the Sudan is that the disease came in from the West

through Darf^{ur} to Kordofan about 1875. It is then reported to have caused much heavier losses than rinderpest did later. During the Mahdia the cattle were badly looked after, many were killed or stolen and when the tribes returned to their homes and depleted herds in 1899 the disease appears to have died out.

The next appearance of pleuro-pneumonia in Kordofan was in 1911 or early in 1912 when it again entered through Darfur, this time owing to the movement of infected trade cattle from French Equatorial Africa. During 1913 the disease spread to the Nuba Mountains, White Nile, Blue Nile, Dongola and Bahr-el-Ghazal Provinces; in 1914 it appeared in Khartoum Province: in 1917 Kassala Province was involved and finally, in 1923, it spread from Kassala to Berber Province.

The present position appears to be that the disease has been stamped out except in the Provinces of Darfur, Kordofan and the White Nile. Outbreaks occurred in the Blue Nile Province during the year but these occurred in work oxen purchased from the White Nile Province and they are now considered to be well under control.

Although 829 cases of pleuro-pneumonia came under notice in the Provinces during the period under review as compared with 811 in the previous year. Two hundred and forty-five cases were reported from the various quarantine stations this year.

Proceeding on the lines successfully adopted at the Veterinary Research Laboratory in Kenya Colony for the production of an effective and safe vaccine against this disease by attenuation of the virus through repeated sub-cultivation in special media, the Veterinary Research Officer has produced a vaccine which has given satisfactory results in the Laboratory. If the results obtained in the field are equally good pleuro-pneumonia will cease to be the formidable disease it has been in the past in this country. The technique of the inoculation is simple so that it can be carried out by trained Veterinary police.

Anthrax.

Only one outbreak of anthrax was reported from the Provinces during the year and that occurred in the Nuba Mountains Province. In the various quarantine stations, however, the position was not so satisfactory as eighty cattle succumbed to the disease within a period of four months. Although only seven of these cases occurred in the old quarantine park at Shambat, Khartoum, it was evident that this park was responsible for infecting practically all the cattle which died at the other quarantine stations. As soon as the new quarantine station at Khartoum North was completed the use of the old park was discontinued and the mortality from anthrax ceased shortly afterwards.

It has been demonstrated in other countries that the only effective way to prevent anthrax infection is by the use of vaccine and steps are accordingly being taken to prepare a standardised vaccine at the Veterinary Laboratory. This vaccine will be used on all export cattle

leaving El Obeid during what is considered to be the anthrax season and, if the results are satisfactory, it will be generally applied to all export cattle in future.

Foot-and-Mouth Disease.

Outbreaks of foot-and-mouth disease occurred in the Kordofan, White Nile and Blue Nile Provinces during the year. This disease has apparently existed in the Sudan for many years and, as far as can be ascertained, has never shown any tendency to assume a virulent form. It is not surprising therefore that it is regarded by the natives as being of little economic importance and, if it were not for its effect in interfering with the export of cattle to Egypt, its presence, for all practical purposes, might be ignored.

The effect which this disease had on trade during the year is outlined in the section of this report dealing with the export trade in cattle.

Forty-two per cent. of the total number of cases of contagious and infectious diseases which came under notice in the various quarantine stations during the year were cases of foot-and-mouth disease.

Trypanosomiasis.

This disease appears to be widespread in the Bahr-el-Ghazal and Mongalla Provinces but, apart from these areas and a small portion of the Nuba Mountains Province, it cannot be described as a common cause of mortality in cattle.

A reference to the distribution of tsetse flies will be made in dealing with the disease in horses, mules and donkeys.

II.—DISEASES OF CAMELS.

The most prevalent diseases of the camel are trypanosomiasis and mange.

Trypanosomiasis.

Forty-two per cent. of the casualties which occurred during the year in camels belonging to Government officials and employees were returned as due to trypanosomiasis and, in parts of the Kordofan, Darfur and Kassala Provinces, the annual losses amongst native-owned camels from this cause must be considerable. Various blood-sucking flies are suspected of transmitting the disease from sick to healthy animals but the natives of Kordofan and Darfur are unanimous in attaching most blame to the "seroot" fly or "Tair el Aghabish" (*Tabanus taeniola*). It is rather peculiar that the only species of *Pangonia* occurring in the Sudan—*Pangonia ruppellii*—is not considered by these natives to be generally associated with the transmission of trypanosomiasis since this fly causes so much annoyance to their herds that, during the season when it is prevalent, they graze their animals at night and protect them from attack during the day by means of smoke fires.

"Seroot" flies occur over a large belt extending across the whole country soon after the advent of the rains and are particularly pre-

valent during the months of August and September. The tsetse fly is not known to occur in the camel-breeding areas of the Sudan so cannot be implicated in the spread of the camel trypanosome common in the country.

The preventive measures adopted by the natives consist in moving their camels to grazing areas in the North, as free as possible from "seroot" flies, during the season when these flies are prevalent in the southern grazing grounds. If in addition to this all infected camels could be detected, isolated and treated, their losses would be reduced considerably.

The "formol-gel" test has recently given very satisfactory results in the diagnosis of this disease and, where applicable, constitutes a very valuable adjunct to the ordinary method of examining the blood microscopically. The value of "Naganol" as a curative agent has also been definitely proved and the details of recent experiments in these connections will be found in the appended report of the Veterinary Research Officer.

Mange.

Mange is responsible for a considerable wastage of camels annually and, in this respect, ranks second only to trypanosomiasis.

As far as Government camels are concerned, when preventive measures are adopted as a routine practice and cases are treated properly in the early stages, losses due to mange should be negligible. The necessary supervision, however, is not always possible and when the disease occurs among the camels of an isolated police post it is seldom properly treated in the early stages and, when an opportunity of dealing with it presents itself, the loss of condition is usually considerable and the difficulties of eradicating the disease are increased enormously.

The dipping of camels in sheep-dipping fluid has proved to be an excellent preventive of mange and chronic cases of the disease respond readily to the thorough and systematic application of greasy dressings containing paraffin and sulphur.

When mange appears in a breeding herd it is a very serious condition and causes considerable losses among foals. The native treatment for mange consists in applying "Gatran"—a wood tar produced locally—but camels treated with this material not infrequently succumb to heat stroke if exposed to the sun.

III.—DISEASES OF EQUINES.

The following animals—horses, mules and donkeys—the property of Government officials and employees, died or were destroyed during the year:—152 horses, 107 mules and 34 donkeys; of these 27 horses and 58 mules died of horse-sickness, 11 horses and 12 mules were destroyed on account of epizootic lymphangitis and 19 horses, 14 mules and 1 donkey died of trypanosomiasis.

Horse-sickness.

Horse-sickness has probably existed in the Sudan from the earliest times and the greatest losses from this disease occur after seasons of heavy rainfall. As an example of this it may be mentioned that the average annual rainfall in Wad Medani for the past nineteen years was approximately 15 inches, the highest rainfall recorded occurring was in 1922 when, during the five months, June to October inclusive, 24 inches fell; the following autumn and winter constituted the worst horse-sickness season experienced in that district.

In bad horse-sickness years it is estimated that the mortality from the disease in southern Kordofan may be as high as 7 to 10 per cent. of the total horse population but, as far as can be ascertained, the total losses this year were small as compared with those of the three previous years.

It may be said that, with the exception of the southern end of the Red Sea Province, horse-sickness is a disease of little importance north of the sixteenth parallel.

If horses are housed in mosquito-proof stables from just before sunset until after sunrise there is little risk of losses from horse-sickness and the cost of rendering a stable mosquito-proof is small compared with the value of a good pony.

Trypanosomiasis.

The majority of cases of trypanosomiasis in horses, mules and donkeys occur in animals which have traversed tsetse fly areas, but occasionally cases come under notice where there is no such history. The area lying between the Bahr-el-Arab and the White Nile is heavily infested with tsetse flies and, to the east of the White Nile, they are to be found in most parts of the Mongalla Province. With the exception of a strip about a mile wide along the northern bank of the Bahr-el-Arab the Provinces of Darfur and Kordofan appear to be free but there is a "fly belt" in the Koalib hills of the Nuba Mountains Province. Tsetse flies from these areas have been identified as follows :

- (1) *Glossina palpalis* from the Bahr-el-Ghazal and Mongalla Provinces.
- (2) *Glossina morsitans* from the Bahr-el-Ghazal, Mongalla and Nuba Mountains Provinces.
- (3) *Glossina fuscipleuris* caught at Yambio in the Bahr-el-Ghazal Province.
- (4) *Glossina longipennis* from the Mongalla Province.

The Department is greatly indebted to Mr. H. H. King, the Government Entomologist, for much information on this subject and also for his kindness in classifying various blood-sucking flies, ticks, etc., collected from time to time.

Epizootic Lymphangitis.

This disease is prevalent in the Fung, Nuba Mountains and Upper Nile Provinces and would appear to have been introduced to these areas by infected animals imported from Abyssinia. Of the few

cases which come under notice in Khartoum and Omdurman most can be traced as having come from the South. *Epizootic lymphangitis* affects horses, mules and donkeys and as it is spread from sick to healthy animals through wound infection, little difficulty should be experienced in eradicating the disease provided the necessary preventive measures are promptly adopted. The immediate destruction of infected animals is an economy in the end but, as the incubation period of the disease may extend to several months, it is necessary that any equine which has been in contact with an infected animal should be kept under observation for a period of nine months.

Habronemiasis. (Bursati.)

Twenty-six cases of this condition were diagnosed at the Veterinary Laboratory during the year and it is only considered necessary here to direct attention again to the necessary prophylactic measures which briefly consist of reducing the number of flies as far as possible, the provision of eye fringes, the prompt disposal of all stable manure by incineration or burial and the protection of all wounds from flies.

Piroplasmosis.

Twelve cases of piroplasmosis in horses came under notice during the period under review. The local animal appears to possess a considerable degree of tolerance to this disease so that it only assumes a serious character in imported horses.

IV.—DISEASES OF SHEEP AND GOATS.

Sheep Pox.

A few mild cases of this disease, amounting to about four per thousand, came under notice in sheep intended for export. Sheep pox appears to be widely distributed throughout the country but rarely causes any mortality.

Anthrax.

Eight cases of anthrax in sheep occurred at the quarantine station at Wadi Halfa in sheep intended for export. The outbreaks were dealt with by the use of anti-anthrax serum obtained from Italy.

Contagious Pleuro-pneumonia of Goats. (Abu Nini.)

Outbreaks of this fatal disease of goats were reported in the Blue Nile and Khartoum Provinces but there appears to be little doubt that the disease is prevalent in most parts of the country.

V.—DISEASES OF DOGS.

Rabies.

An outbreak of rabies was reported from south-eastern Darfur in October, 1924, and natives, as well as donkeys and cattle, were said to have contracted the disease and died. Later it was reported that the disease had spread to south-western Kordofan but by the time these reports had been received practically all the dogs in the infected areas had been destroyed by the natives and no material was obtainable from which a definite diagnosis could be made. Outbreaks of rabies were previously reported in the Sudan in 1904, 1905, 1908 and 1911, but none of these apparently assumed serious proportions.

VI.—DISEASES OF POULTRY.

The commonest causes of mortality amongst poultry are *Spirochaetosis* and fowl plague. The former disease affects fowls, turkeys and pigeons and is transmitted by the fowl tick (*Argas persicus*). As the adult ticks hide in crevices in the fowl house through the day and only come out at night to suck blood, their attacks can be prevented by suspending the perches from the roof of the fowl-house by means of wires and dressing these wires at frequent intervals with tar. Broody hens may be protected from ticks by placing them in a box supported on legs the feet of which are immersed in dishes containing paraffin oil or a solution of disinfectant. In addition to the above precautions the fowl-house should be thoroughly sprayed once a week with strong paraffin and soap emulsion.



SECTION II.

EXTERNAL AND INTERNAL TRADE.

1. EXPORT TRADE.

Cattle and Sheep.

On several occasions during the past three years the export trade in cattle has been seriously affected by the occurrence of outbreaks of foot-and-mouth disease. In all outbreaks which have come under notice the disease has proved to be of a very mild type causing little or no loss of appetite or of condition. In the dry season, however, the mouth lesions take a long time to heal owing to the irritation set up by the dry, hard and frequently spiny herbage on which the cattle are compelled to feed and, for this reason, a considerable period elapses before animals which have had the disease can be passed as fit for export.

During the period under review outbreaks of foot-and-mouth disease at El Obeid resulted in about 7,000 head of cattle being detained there for over 4 months and the extension of the disease to the quarantine station at Wadi Halfa prevented any cattle from leaving that station for periods amounting to over 9 weeks. Outbreaks of rinderpest also caused delays in clearing cattle from Wadi Halfa and, when these facts are considered, it is not surprising that the exports of cattle through that port fell from 12,726 head in 1922-23 to 9,164 head this year.

The situation would have been rather serious for the cattle traders if it had not been relieved by the utilisation of Port Sudan as an outlet for cattle intended for the Alexandria market: 6,741 head of cattle were despatched by this route so that the total deficit in the numbers exported as compared with last year was reduced to 268 head.

When no more cattle could be drawn from El Obeid on account of the existence of foot-and-mouth disease it was hoped that the Kassala district would be able to supply requirements, but, when a rapid survey of this district was made, it was estimated that, after allowing for the large local demand for meat, there could only be a negligible surplus available for export.

Attention has since been directed to the possibility of obtaining supplies from the Upper Nile region. During the year tribute cattle to the number of 262 from the Bahr-el-Ghazal Province and of 96 from the Mongalla Province were sent to Khartoum to be disposed of. These cattle were very mixed lots but realised the sum of £E. 1,040, and 136 of them were passed as fit for export. It is understood that large quantities of slaughter cattle can be purchased in the two Provinces mentioned and, provided care is exercised in their selection, and transport facilities can be provided, it should be possible to develop quite a considerable and profitable trade in them.

The number of cattle exported during the year was 15,905 head and, in this connection, it may be pointed out that during the same period our imports of cattle amounted to 11,704 — 724 head from

Eritrea, 5,601 from Abyssinia and 5,379 from French Equatorial Africa. In the previous year 16,173 head of cattle were exported and the total imports amounted to 13,452 — 621 from Eritrea, 5,716 from Abyssinia and 7,115 from French Equatorial Africa.

For the purpose of comparison the numbers of cattle and sheep exported each year during the past four years are shown below :—

Years.			Cattle.	Sheep.
1921-22	...	...	23,066	40,400
1922-23	...	...	12,654	23,300
1923-24	...	...	16,173	31,845
1924-25	...	...	15,905	28,531

In addition to our trade in cattle and sheep it may be noted that the Customs returns show that 33,149 kilos. of dried meat (biltong), valued at £E. 3,303, were exported to Egypt in 1924.

Camels.

9,611 Camels were exported from Kassala and Berber Provinces to Egypt during the year.

Quarantine Stations.

The erection of new quarantine stations at Khartoum North, Wadi Halfa and Port Sudan was completed during the year. The yards are constructed of old rails supplied by the Sudan Railways and they are a great improvement on the old mud-walled enclosures.

The provision of two quarantine stations at Wadi Halfa considerably lessens the risk of a stoppage of trade resulting from the occurrence of an outbreak of disease in any consignment of cattle.

The new quarantine station at Khartoum North is five kilometres nearer the town than the old station and can therefore be kept under close observation.

Hides and Skins.

The numbers of hides and skins inspected for export as compared with the three previous years were as follows :—

Years.			Hides.	Skins.
1921-22	...	...	16,870	309,987
1922-23	...	...	24,668	316,986
1923-24	...	...	22,102	273,820
1924-25	...	...	61,593	355,865

The figures for last year show a substantial increase on previous years and it is thought that this trade might justly receive more attention than it has in the past.

The hides and skins of animals slaughtered in the principal towns are usually carefully prepared and exported in good condition, but those prepared by the natives in the outlying districts (" flint dried " or " Fashoda " hides) are generally of very inferior quality owing to faulty flaying and bad methods of preparation.

An opportunity was taken to discuss, with some of the leading hide merchants, the question of the best method of effecting an improvement in the quality of hides and skins offered for sale and it is considered that practical demonstrations given by members of the Veterinary native staff, specially trained in the work, would be more effective in achieving the desired object than any other. In the meantime a pamphlet on the subject is in preparation for distribution to Administrative officers and, provided the commercial firms will assist by paying discriminating prices for varying grades of hides, as has been done recently in Uganda, a marked improvement should be possible.

Samn.

Large quantities of clarified butter (samn) of good quality are prepared by the Arab cattle-owning tribes and most of it is consumed locally. The Customs returns, however, show that 64 tons, valued at £E. 6,051 were exported in 1924 and, of this quantity, 63 tons went to Egypt.

II.—INTERNAL TRADE.

Local Livestock requirements.

It would appear that, in the past, there has been a tendency to direct attention mainly to the value of our export trade in livestock and livestock products and to overlook the importance of our internal trade. It is therefore considered advisable to indicate briefly what the local requirements are in this connection.

It is impossible to estimate the total amount of meat consumed throughout the country annually as the diet of the different tribes varies enormously but the following figures which represent the total numbers of animals slaughtered for human food, during the past year, in the towns of Khartoum, Khartoum North, Omdurman, El Obeid, Wad Medani, Kassala, Gedaref, Atbara, Port Sudan and Wadi Halfa, are considered to give an interesting indication :—

					Head.
Cattle	...	...	...	...	22,900
Sheep	...	...	...	...	138,200
Goats	...	...	...	...	11,000
Camels	...	...	...	...	1,830

The value of an adequate meat ration is readily apparent when one compares the physique of the members of a meat-eating tribe with that of one whose members cannot obtain sufficient meat and who consequently subsist largely on grain.

Practically all the best slaughter cattle are exported owing to the high prices obtaining on the Egyptian market and, consequently, the type of animal which is slaughtered in Khartoum and Omdurman is generally of inferior quality.

The milk supply of the native population is obtained from cows, goats, camels and sheep and the importance of milk as a food for children cannot be overestimated. It may also be mentioned that camels' milk forms the staple diet of many of the nomadic desert tribes.

The transport requirements of the population are enormous : horses, donkeys and camels are used for riding purposes by all the tribes that possess them, and the pack animals, in their order of importance, are camels, donkeys and bulls. Camel transport, in many parts of the Sudan, is absolutely essential and, in country suited to camels, it is doubtful if it will ever be displaced by motor transport as its average cost rarely exceeds 5 P.T. per ton mile and its use does not involve expense in the making and repairing of roads.

In many of the cotton-growing areas oxen are used for ploughing and cultivating, and with the growth of the industry the demand for oxen for this purpose should steadily increase.

In regard to other livestock products mention may be made of the camel hair and sheep hair which is woven into mats by the various tribes, of the quantities of hair used to stuff pack and riding saddles, and of the considerable numbers of sheep and goat skins which are manufactured into leather locally.

Finally, the importance of livestock from the native's point of view must not be overlooked. His livestock represents his invested capital—the annual increase being regarded as compound interest—and the value of a wife is most commonly represented in terms of livestock.

SECTION III.

STOCK IMPROVEMENT.

Cattle.

The cattle of the Sudan generally conform to the true Zabu type, having small or medium sized horns, a hump and a pendulous dewlap but, in the Upper Nile regions, the common type is a "leggy" animal, carrying massive, long horns and possessing a comparatively small hump. This long-horned type resembles the breed of cattle known in Uganda as the Ankole but is rather heavier built. Another type which is common along the Abyssinian and Eritrean frontiers is under-sized and has apparently resulted from crossing with the small Abyssinian breed of cattle.

Under natural conditions native cattle mature slowly and the average age of those which are exported to Egypt for slaughter may be taken to be six years when they weigh 700 lbs. to 800 lbs. The average yield of milk from a native cow is estimated at 100 gallons per annum after the requirements of the calf have been met, but the butter fat content usually exceeds 5 per cent.

The results of crossing native cows with imported shorthorn and Egyptian bulls have been very satisfactory from the point of view of milk production in the Government Dairy herd and one cow yielded 800 gallons during her last lactation period.

The American Mission at Gereif, near Khartoum, imported a young Friesian bull and heifer in November. The bull suffered from a severe attack of tick fever soon after he arrived but made a good recovery and has since served a number of cows at the Government Dairy.

In many parts of the Sudan, during the dry season, the grazing is so scanty and the distance between water and grazing so great that only animals specially adapted to local conditions can hope to survive. The existing types of animals, which are capable of withstanding considerable degrees of hardship in the shape of starvation, thirst and heat, might be taken, therefore, as being the types best suited to the country since they have evolved under natural conditions. It does not follow from this, however, that the indigenous animal cannot be improved without some loss of the qualities which enable it to survive through the worst periods of the year since evidence is not lacking to show that marked improvement can be effected, without such loss resulting, by breeding from selected local types. On the other hand it would not be wise to assume that the progeny of imported English bulls would thrive under the conditions obtaining in the arid and semi-arid zones of the country. The probability is that they would prove quite unsuited to these areas but, in the well-watered districts to the South, areas might be found which would prove to be suitable for the "grading-up" of native cattle by the use of imported bulls.

Little has been done in the past to improve the local breed of cattle, but a commencement was made on a small scale in the Kassala District during the year. The cattle around the town of Kassala are, generally speaking, under-sized animals of the small Abyssinian type and it is hoped that an improvement in their size can be effected

by the introduction of a large type of bull from the White Nile Province. Thirty bulls were purchased from the Sellim tribe in August and moved to Kassala where they were sold to certain owners of selected herds who agreed to have all the bulls which they had previously been using castrated.

With a view to encouraging natives to exercise greater care in the selection of their Stud bulls, the Governor of Kordofan Province has arranged to introduce classes for bulls at the forthcoming Animal Shows in his Province, and if similar arrangements can be made in other Provinces nothing but good can result.

As in more civilized countries, improvement in the breeds of animals cannot be more easily and effectively fostered than by educating the public taste and by stimulating effort through the medium of animal shows.

Horses.

It is estimated that there are about 20,000 horses in the country and that approximately 80 per cent. of these are owned by the pastoral tribes of Darfur and Kordofan. Generally speaking, the horses are of poor quality as evidenced by the fact that some difficulty has been experienced in obtaining the necessary Government requirements locally.

The indigenous horse of the Northern Sudan, the Dongolawi, has been responsible for much of the objectionable conformation possessed by the local breed and it will take some time to eradicate these faults by the use of suitable sires.

In Kordofan the Messeria tribe still produces the best animals and can supply a certain number of suitable remounts but, although the Homr tribe possesses large numbers of horses, they produce very few useful animals, the majority being under-sized ; the Hawazma horses are a mixed and indifferent lot.

Darfur appears to be the most suitable Province from a horse-breeding point of view. It possesses the largest horse population, forage and grazing is plentiful, the natives are easy to deal with and are willing to be advised, and the results obtained during the past few years are reported to be very encouraging.

In spite of inadequate staff and supervision considerable progress has been made, both in Kordofan and Darfur, by encouraging the use of selected local sires and it is proposed to continue this practice, particularly in districts where horse-sickness is prevalent. In other districts it is hoped to produce comparatively rapid improvement by the introduction of Arab blood, as the value of the Arab cross has already been proved in the country.

Judging from the results obtained so far it is reasonable to presume that, if horse breeding is developed along the present lines, a suitable, general utility horse will, at no far distant date, be available in sufficient numbers and at a reasonable price.

At the present time the Government possesses the following stallions :—

"Diamond Jubilee"	...	Egyptian country-bred.
"Malik"	...	Arab.
"Zanati"	...	Arab.
"Sultan"	...	Arab.
"Kiolan"	...	Arab.
"Sawari"	...	Syrian.
"Darwish"	...	Arab.

Two of these stallions, "Malik" and "Zanati," the property of the late Sirdar and Governor-General, Major-General Sir Lee O. F. Stack, were very kindly presented to the Department by Lady Stack, and the Arab racing pony "Darwish" was generously presented by Captain H. G. B. Ferguson of Ramleh, Egypt.

In addition to the above, three Syrian stallions, which were cast from the Army, have been purchased.

The Government sires which stood at Khartoum and Shendi during the year served 150 mares and—in spite of the lack of forage—this year's crop of foals in Khartoum District is very promising.

Camels.

Sudanese camels may be roughly divided into three types, namely, the so-called Bisharin breed of the North-eastern Sudan, the Shukria-Anafi breed of Kassala and the Arab breed of Kordofan. Between these three types all sorts of varieties are to be found as the result of cross-breeding. Each type may be said to be particularly suited to the country in which it is bred. The best riding camels are bred in the Red Sea and Berber Provinces and in Northern Kassala. The best baggage camels are probably those bred in Northern Kordofan. Generally speaking, the camels bred to the North of Parallel 15 are hardier and of a better type than those bred to the South of this line.

With a few exceptions it may be said that the native camel owner practises no sound system of breeding, his main object being to produce size and to increase his herd.

It is understood that arrangements are being made by the Governor, Red Sea Province, to organize a Camel Show at Salala during the coming winter. It is hoped that this will receive the support of the camel-owning tribes and that it will become an annual event, as it will provide an excellent opportunity for inspecting stock and for giving advice and instruction to the owners with a view to improving the breed. It would also be a convenient time to purchase any camels required by the Government.

Donkeys.

The common type of donkey found in the middle and Northern Sudan is small and often weedy but extremely hardy. He is called upon to carry loads of 200 to 300 lbs., is generally worked long before he reaches maturity and is frequently underfed.

The asses of the Red Sea and of Northern Darfur are of good size and type. They are bred under desert conditions and closely resemble the wild ass. A few jennets bred by this Department in 1915 from Red Sea asses are reported to have been of excellent type and size.

The Sudan riding donkey is longer in the leg than the common donkey, has a fine coat and shows more quality. He is a native of the Northern Sudan and is usually of a slatey grey or brown colour with, occasionally, zebra markings on the legs. Some are white in colour, generally indicating an admixture of Egyptian blood, and such animals, as a rule, are not so hardy as those of other colours. The riding donkey is a good weight carrier and will travel at 5 miles per hour over long distances. The price of a good donkey of this type is from £E. 10 to £E. 15 or even more.

Careful selection is usually practised in breeding riding donkeys but little can be done to improve the common donkey as the natives object to castrating their stallions.

Sheep.

The typical sheep of the Sudan may be described as being of the long-legged and long-tailed variety. Among its differentiating features may be mentioned the following: The presence of horns in the ram (generally rudimentary) and their absence in the ewe, the presence of hair instead of wool, the rarity of throat wattles, the convexity of the nasal region, the absence of hair on the under side of the tail, the pendant ears and the predominance of light parti-colouring.

The largest sheep come from the desert regions of Kordofan and a smaller type is found in the Butana District of Kassala Province.

Another type of sheep known as the "Zaghawa" is found in North-west Darfur. These sheep carry a complete covering of woolly hair from 3 to 4 inches in length, they are black in colour with white tips to their tails, the males are horned and occasionally rams bearing four horns are noticed. It is interesting to note that rams bearing four horns are generally piebald or skewbald.

A variety of small, maned sheep is to be found in and around the Nuba Mountains Province. They are comparatively small, short in the leg, with markedly convex nose, horns constantly present in the ram and a distinct mane of long, rough hair which extends along the back. Like the goat of that locality they are of all colours save black.

South of parallel 14 the sheep are small.

A few fat-tailed sheep are to be found in the Red Sea Province, the result of the introduction of breeding rams from the Hedjaz.

Efforts have been made to introduce the fat-tailed Egyptian woolled sheep locally, and a flock of this breed was maintained in Khartoum by the Government until recently. The natives, however, showed little interest in the breed and as the cost of maintaining the flock was considerable it was decided to discontinue the experiment.

It does not appear probable that wool-production will ever be a commercial proposition on any scale in this country as, apart from the climatic conditions, the presence in many areas of harmful grasses such as "heskaneit" (*Cenchrus contortus*) would prove fatal to such an enterprise.

Goats.

The common ("Beladi") goat of the Northern Sudan is generally black in colour, often with a grey or white head, ears and points; the ears are large and lop, the horns are short and curve outwards and backwards, the beard is short and the coat, when in good condition, is long and wavy. The goat of the towns, whose diet during the dry season appears to be chiefly tree clippings, waste paper and rubbish, with an occasional ration of "mushak" (local brewers' grain), is generally in poor condition but is capable, nevertheless, of producing considerable quantities of milk. The majority produces one kid at a birth and breeds twice a year. It is estimated that the average milk yield is between 30 and 40 gallons per lactation period although some well-fed goats have been known to yield much more.

Another distinct type of goat is found in the Nuba Mountains Province. It may be described as the "Gebel" goat and it is a small, thick-set animal, carrying a lot of condition and generally resembling the type common in Western Abyssinia. The male carries massive horns of moderate length, the beard is long and the long, rough hair of the mane extends along the middle line of the back. Females produce two kids at a birth and usually breed twice a year. The milk yield is comparatively small.

South of parallel 14 the common goat is a cross between these two types.

Poultry.

The native fowl is a very small bird and lays an egg which is not much bigger than that of a bantam.

Considerable success has attended the efforts of one or two poultry fanciers to improve the local breed by crossing with Wyandotte and Rhode Island Red roosters imported from England. Although the pure-bred imported fowl does not stand the climate the cross-breeds do well, are a marked improvement on the native bird and lay eggs almost as large as those of imported hens.

No attempts have apparently been made to improve the local breed of duck or turkey.

Dogs.

Repeated attempts have been made to establish pure-bred dogs, imported from England, in the country. It cannot be said, however, that any marked success has been achieved in this direction.

Crosses between imported breeds and the native dog of the country are fairly numerous and seem to stand the climate quite well.

SECTION IV.

MISCELLANEOUS.

Animal Population.

The only figures available with regard to the animal population are those shown in the herd tax lists and, according to these, 825,558 cattle, 346,457 camels, 17,102 horses, 288,161 donkeys, 1,639,063 sheep and 1,534,288 goats were assessed for animal tax in 1924.

In the case of camels, horses and donkeys, if 20 per cent. were added to the figures shown, to represent the number of immature stock which are not listed, it is thought these totals might then be taken to be approximately correct, viz., 418,150 camels, 20,500 horses and 345,600 donkeys.

The figures for cattle, sheep and goats, however, do not represent anything like the numbers which are in the country as no herd tax is collected in Mongalla Province and only a small percentage of the cattle, sheep and goats in Bahr-el-Ghazal Province are listed. Taking the area covered by the Provinces of Darfur, Kordofan, Fung, White Nile and Upper Nile, the average number of cattle works out at 2.12 head per square mile and, if these figures are applied to the Provinces of Mongalla and Bahr-el-Ghazal, the combined areas of which approximate 200,000 square miles, the number of cattle would be about 424,000 head. It is thought, however, that this would prove to be an underestimate and that the total number of cattle in the country may tentatively be taken to be somewhere about 1,500,000 head.

If the numbers of sheep and goats are estimated on similar lines the total would approximate 5,250,000 head.

Disposal of Carcases.

The common method of disposing of the carcases of dead animals in the Northern Sudan is to deposit them on a piece of land, allotted for the purpose, outside each village or town and there to leave them to be devoured by pariah dogs, vultures, hyaenas and other scavenging animals. Owing to the sterilising action of the sun coupled with the small rainfall, little if any harm seems to result from this practice but it is to be hoped that, with the growth of the cotton industry, a demand will arise for bones for manurial purposes and the existing unsightly heaps of bones around the various towns will disappear.

Until recently the method adopted in the various quarantine stations for the disposal of anthrax carcases was cremation on the surface of the ground by the use of the cross-trench system described in some Military text-books. This system was found to be unsatisfactory as it took a considerable time to effect complete incineration, the amount of fuel required was considerable and it was necessary to post night-guards to keep scavenging dogs away from the carcases. It was therefore suggested that Bostock's method of cremation in a pit should be given a trial and this has proved to be most effective and economical. It is the method recommended by the Ministry of Agriculture of Great Britain.

Grazing and Watering Facilities for Livestock.

In years when the rainfall is good and general, grazing and water is plentiful, stock do not concentrate in large numbers in restricted areas and consequently there is less risk of any outbreaks of disease, which may occur, becoming widespread and causing heavy losses. When the rains fail losses from starvation are inevitable and the risk of losses from disease is considerably increased.

The average rainfall of the Middle and Northern Sudan can only be described as scanty and the rainy season may be said to extend from about mid-June to mid-October. Under natural conditions the stock-carrying capacity of an area is limited by the amount of grazing available, during the dry season, within a reasonable distance of water. It therefore follows that if this capacity is to be increased and provision made for years of light rains it will be necessary to take steps to protect the grazing areas from grass fires and to improve the water supplies.

It is almost impossible to prevent grass fires from occurring but much can be done in this direction by keeping all main roads and camping grounds clear of grass, by enforcing rules for extinguishing camp fires and by the infliction of heavy fines when the culprits can be found.

If adequate fire-breaks are made at intervals in a grazing area the effects of grass fires can be considerably localized and it is considered that all the best grazing areas could be protected in this way. The making of fire-breaks need not be expensive as the necessary work could be carried out by the stock-owners concerned under proper supervision.

In regard to water supplies considerable assistance would be rendered to the nomadic tribes if even the existing wells and water reservoirs were improved so that the watering of stock would be facilitated. It is considered that any expense incurred in this direction would be amply repaid in the shape of increased revenue from herd tax. It is not suggested that expensive wells be sunk or deep bores made and fitted with pumps which would necessitate the employment of mechanics.

Owing to the partial failure of the rains this year it is feared that the necessity of conserving all grazing and water possible will be emphasized during the coming summer.

Livestock in relation to Cotton Production.

The problem of the best method of utilising livestock in connection with the Gezira canalization scheme, primarily with a view to improving the soil, is one which engaged a considerable amount of attention during the year. After every aspect of the question had been carefully considered it was thought that the indications were strongly in favour of the adoption of a system by which the tenants would be required to maintain a certain number of cattle on their holdings throughout the year. Before further steps are taken in the matter, however, it has been decided to obtain definite information as to the number of cattle which could reasonably be maintained on each

holding and as to the effect this number would have in increasing the yield of cotton. A feeding and manurial experiment is therefore in progress and it is hoped that the results will prove to be of considerable value.

A report of this nature, which necessarily includes a brief review of past veterinary activities in the Sudan, would not be complete without a reference to the late Lieut.-Colonel F. U. Carr, Army Veterinary Corps, who was Principal Veterinary Officer, Egyptian Army, and Director of the Veterinary Department, Sudan Government, from 1908 until his death in 1917. During these nine years this Officer threw his whole heart into the task of developing the livestock industry of the country and the credit of any success that has been achieved is mainly his. His views with regard to the lines on which the stock industry should be developed were very similar to those held by Sir F. D. Lugard and this report may fittingly be concluded by quoting the following from the latter's book "The Dual Mandate in British Tropical Africa":—

"If it be our aim to teach the natives how to develop the resources of their country themselves in the most efficient way, there is perhaps no sphere of industrial activity in which an object-lesson is more essential than in that of stock-raising. For there is no class more conservatively ignorant than the pastoral races of Africa, whose methods have not changed since the time of Abraham. To such people no means of education other than ocular demonstration is of any use whatever."

"The educative value of an object-lesson in the treatment of the common diseases, isolation against contagion, selection for breeding, the flaying of hides, and fattening for market, etc., cannot be overrated. But the application of modern science can do more than this. By artesian well-boring, and raising water by mechanical appliances and irrigation, by importing stock and cross-breeding, by introducing new fodder grasses and scientific methods of storing them, by utilising local oil-cake for fattening, and by creating a steady market, a trade of great value may be built up. The wild nomad pastorals of to-day may become the stock-raisers of to-morrow, and the yearly increment of the herds, instead of perishing by epizootic disease and the starvation of the dry season, may provide food for the industrial classes of Europe, who in turn will raise the standard of comfort of the natives by their manufactured goods. We have seen the process at work all over the world; it is no longer the fanciful picture of the enthusiast."

Khartoum.

W. KENNEDY.

16th November, 1925.

Director, Veterinary Department.

APPENDIX I.

**REPORT OF THE VETERINARY RESEARCH OFFICER, SUDAN
GOVERNMENT, FOR THE PERIOD OCTOBER 1st, 1924, TO SEP-
TEMBER 30th, 1925.**

To :—

The Director,
Veterinary Department, S.G.,
Khartoum.

VETERINARY RESEARCH LABORATORY,
KHARTOUM.
October 14th, 1925.

SIR,

I have the honour to submit, herewith, a report on the work at the Veterinary Research Laboratory for the year.

(a) ROUTINE EXAMINATIONS.

During the year 733 smears and specimens have been examined and reported on, excluding the examinations carried out in the course of research work.

Horses.

Piroplasmosis	...	...	...	...	...	...	12
Trypanosomiasis	...	...	...	...	...	...	2
Habronemic Granuloma (Bursati)				...	...	...	11
Habronemic Conjunctivitis			...	...	...	...	5
Epizootic Lymphangitis	...		...	...	...	...	9
Ulcerative Lymphangitis			...	...	...	...	1
Strangles	...	...	...	...	...	...	1
Pyogenic Infections		...	...	...	...	...	2
Forage Acari	...	...	...	...	...	...	1
Lichen Tropicus		...	...	...	...	...	10
Negative	...	...	...	...	...	...	59
							<hr/>
						TOTAL	...
							...
							113 113

Mules.

Epizootic Lymphangitis ...	...	...	...	...	...	12
Habronemic Granuloma ...	...	...	...	...	...	6
Habronemic Conjunctivitis	...	...	...	...	...	4
Piroplasmosis ...	...	...	...	...	...	1
Trypanosomiasis ...	...	...	...	...	...	1
Pyogenic Infections	...	...	...	...	...	2
Negative ...	...	...	...	...	...	42
TOTAL						68
						181

Donkeys.

Trypanosomiasis	...	...	...	...	...	...	2
Piroplasmosis	...	...	...	...	...	...	1
Filariasis	...	...	...	...	...	...	1
Negative	...	...	...	...	...	...	24
TOTAL							28 209

Camels.

Trypanosomiasis	...	...	...	...	...	...	64
Mange	...	...	...	...	...	...	18
Filariasis	...	...	...	...	...	...	8
Streptococci	...	...	...	...	...	...	6
Peritonitis (fibrinous)	...	...	...	...	...	...	3
Helminthiasis	...	...	...	...	...	...	3
Echinococcus Cysts	...	...	...	...	...	...	6
Negative	...	...	...	...	...	...	156
TOTAL							264 473

Cattle.

Anthrax	...	...	...	...	...	...	76
Piroplasmosis	...	...	...	...	...	...	15
Trypanosomiasis	...	...	...	...	...	...	5
Contagious Bovine Pleuro-pneumonia	...	...	...	...	...	...	12
Rinderpest...	...	...	...	...	...	...	8
Bilharzia	...	...	...	...	...	...	3
Tuberculosis	...	...	...	...	...	...	1
Negative	...	...	...	...	...	...	100
TOTAL							200 693

Sheep.

Anthrax	...	...	...	...	...	...	8
Negative	...	...	...	...	...	...	7
TOTAL							15 708

Dogs.

Piroplasmosis	...	...	...	...	...	...	2
Negative	...	...	...	...	...	...	23
TOTAL							25 733

(b) REVIEW OF DISEASES.

Trypanosomiasis.

(a) Camels.

During the year 64 cases of Trypanosomiasis of camels have been diagnosed microscopically at the Laboratory, and 61 cases were diagnosed microscopically in No. 5 Coy. Camel Corps at Wad Medani,

during the investigation into the disease. It is unnecessary here to make more than a passing mention of the widespread nature of this disease and the large financial losses annually incurred by the Government owing to this disease.

Investigations in treatment and diagnosis were continued during the year.

Treatment.—The therapeutic treatment of camel Trypanosomiasis with Bayer 205, now known as Naganol, has been continued.

The promising results obtained at the laboratory last year have been verified in the field on a sufficiently extensive scale to advise the purchase of a large amount of Naganol from Germany.

Having found that Naganol was a cure for this disease, the work consisted of ascertaining the minimum dose efficient for a cure.

It has been found that the minimum dose that will certainly cure the disease is 10 grammes, administered intravenously in aqueous solution, as a single dose.

The present price of Naganol is P.T. 54 for a dose of 10 grammes and 800 doses are being obtained to carry out the treatment on an extended scale. It is hoped that the financial losses from this disease will be considerably reduced.

Experiments have been commenced to test the efficiency of the treatment of the disease by a combination of Naganol and Antimony Potassium Tartrate, with a view to using smaller doses of Naganol and consequent economy.

The result up to the present is encouraging and the experiments will be continued.

Immunity.—The question presented itself as to whether a camel cured of Trypanosomiasis by Naganol had any immunity against re infection.

A preliminary experiment only has been carried out. This showed that camels cured of Trypanosomiasis by Naganol can be re-infected but that they are more resistant than camels which have never suffered from Trypanosomiasis, and after re-infection they tend to remain in the chronic stage of the disease and remain in good condition.

It is hoped to continue observations on this subject.

Diagnosis.—Further studies on the Formol-Gel test have been carried out. It has been found that the percentage of error is 8. This means that 8 per cent. of healthy camels not affected with Trypanosomiasis will react to the Formol-Gel test, but that this reaction is of a temporary nature. It will be seen then that this error is on the safe side when using the test for the detection of cases of Trypanosomiasis either for the purpose of treatment or purchase. It can be claimed that the Formol-Gel test is of practical value in the detection of Trypanosomiasis of camels. A summary of the work on this disease is given in Appendix I of this report.

(b) *Cattle.*

During the year five cases of Trypanosomiasis have been diagnosed in cattle ; of these two were from El Obeid and one from Talodi, all due to *T. Congolense*. Two from Singa were due to *T. vivax*.

It would not appear to be a widespread infection of cattle in the Sudan, but it must be admitted that our knowledge of the incidence of the disease in cattle is still deficient.

Trypanosomiasis due to *T. congolense* has caused heavy losses in the ox transport at Talodi. Arrangements were made to treat the cases with Tartar Emetic, but these were interrupted by the departure of the Veterinary Inspector from Talodi.

(c) *Horses.*

Two cases of Trypanosomiasis have been diagnosed in horses, one from Rumbek (Bahr-el-Ghazal) due to *T. pecaui* and one from Kosti (White Nile) also due to *T. pecaui*. The latter was brought into Khartoum and treated with Naganol, first dose 3 grammes, and the second dose 2 grammes, at an interval of 9 days.

Toxic symptoms were produced by the Naganol, but these disappeared.

The horse was returned to Kosti and is reported to be fit and well, 8 months after treatment.

Although the treatment was not controlled by microscopic and biological examination, one can assume that the horse is cured, as *T. pecaui* is a fatal infection in horses.

(d) *Mules.*

One case of Trypanosomiasis was diagnosed in a mule at Rumbek, due to *T. pecaui*.

Rinderpest.

In my last report the possibility of manufacturing anti-rinderpest serum in the Sudan was brought forward, and a programme of work to test this possibility was outlined, and has been carried out during the year.

The questions investigated were :—

(a) *The study of the susceptibilities of the native cattle and of the half-bred cattle from the Government Dairy Farm.*

It was found that the young half-bred stock at the Dairy Farm were highly susceptible to rinderpest and were suitable for use as producers of virulent blood, in the production of anti-rinderpest serum.

The experiment suggests that young native cattle are highly susceptible and may be suitable for virus producers.

(b) *A study of the possible complications in serum production by infection with Theileria mutans.* The observations have shown that infection by *Theileria mutans* is very common in the Sudan, but although its presence would have to be controlled by systematic blood examinations it was thought that no serious interference with the routine work of serum production would be caused.

(c) *Extraction of serum from blood.*—This was carried out by the weight method and was found to work well, over 50 per cent. of serum being obtained from the blood.

(d) *The possibility of hyper-immunising adult native cattle and the production of a potent anti-rinderpest serum.* It was found that hyper-immunisation of native cattle could be carried out by injections of virulent blood from infected susceptible young cattle. The virulent blood was injected intramuscularly and was quickly absorbed.

The anti-rinderpest serum thus obtained was then tested and it was found that the standard of potency required for field work was more than attained.

It was found that cattle were protected against the disease by injections of 6.6 c.c. per 100 lbs. body weight, whereas the standard required for field work is 8.3 c.c. per 100 lbs. body weight. Controls were used in these potency tests.

The cost of production was carefully estimated and was found to be a maximum of P.T. 9.4 per dose of 50 c.c., whereas the price which has been paid up to the present is P.T. 15.8 per dose of 50 c.c.

The details of the establishment of a serum institute have been worked out and, together with the details of these investigations, have been embodied in a separate report—already submitted—which will be available when it is decided to establish a serum institute in the Sudan.

In connection with rinderpest, I visited the serum institute in Asmara, Eritrea, in March and there found a large serum institute and a very efficient veterinary organisation for the control of rinderpest in the Colony of Eritrea.

They rely entirely on the double-inoculation or serum-vaccination method, with very satisfactory results.

A provisional contract, since sanctioned by the Sudan Government, was made with the Government of Eritrea to purchase our annual supply of anti-rinderpest serum from them at the price of seven and a half lire (lire 7.5) per dose of 50 c.c.

The following table shows the cost of 12,000 doses (annual requirements) of anti-rinderpest serum at Khartoum, if bought from Cairo (the source up to the present), from Eritrea, or if made in Khartoum.

From Cairo.	Made in Khartoum.	From Asmara.
£E. 1,896	£E. 1,161	£E. 873

It will therefore be evident that a large saving will be made on this item.

The details of my visit to Eritrea, the organisation of their Veterinary Service, and their methods for the control of rinderpest are given in a separate report, already submitted.

Anthrax.

During the year 76 cases of Anthrax in cattle, and 8 cases in sheep, have been diagnosed.

This represents a considerable increase on previous years.

With one exception, namely, a sheep which died on the train between Berber and Wadi Halfa, all the cases of anthrax have occurred in the quarantines of Shambat, Khartoum North, Wadi Halfa, or Port Sudan, or en route between the quarantines, always after the arrival in Shambat or Khartoum.

Only one case of anthrax has occurred in the new quarantine at Khartoum North. The incidence of anthrax died out with the occupation of the new quarantine, the last case occurring in Port Sudan on March 20th, 1925.

This may be due to the normal end of what appears to be an anthrax season, but there can be no doubt that the evacuation of the quarantine at Shambat, which is heavily infected with anthrax, will influence markedly the incidence of anthrax.

Unless comparative observations are carried out with the anthrax vaccine, which it is intended to use this winter, it will be difficult to estimate its utility, even should the incidence of anthrax be low.

Whilst bearing in mind the outbreaks of anthrax amongst the natives of Nuba Mountains Province, the evidence, together with that put forward in my last report, still points to the conclusion that Kordofan is comparatively free from anthrax and that the chief sources of infection are the quarantines.

On the suggestion of the Director of the Veterinary Department, vaccines are being prepared for the control of anthrax.

For this purpose attenuated strains of the anthrax bacilli have been obtained from the Research Laboratory of the Government of the Union of South Africa.

From these a standardised vaccine is being prepared for issue when required by the Department.

For the cremation of carcasses, chiefly in connection with anthrax control, Bostock's pit was suggested and has answered very well. This method appears to be the ideal method of cremation for the Sudan and might with advantage be adopted generally.

Its advantages are:—Economy of fuel. The pit is easily dug and requires no permanent erection. The fire, once alight, requires no attention, complete combustion taking place and the heat is concentrated in the pit.

Contagious Bovine Pleuro-pneumonia.

The losses from this disease continue to be heavy.

The Sudan Plantations Syndicate report the loss of 33 per cent. of their working oxen in 1924.

No reliable statistics as to the actual cause of these losses are available but they are reported to be mainly due to contagious bovine-pleuro-pneumonia.

The numbers of working oxen employed by the Sudan Plantations Syndicate continue to increase and are now about 2,000.

During the year, the work on this disease has been the production of a prophylactic vaccine made from strains of the causative virus grown in the Laboratory.

Six strains of the virus have been isolated from natural cases of the disease.

These by repeated sub-cultivation became attenuated and were then tested on cattle.

Strains have been obtained which, although producing a small harmless reaction, gave a strong immunity against artificial infection with virulent lymph from natural cases of the disease.

The virulence of this lymph was tested on non-vaccinated cattle and gave very severe reactions or death.

Three hundred and seventy doses have been used in the Blue Nile Province, and the vaccine can now be produced in whatever quantity it is required. The vaccination at present involves two doses, but experiments are in progress to produce a vaccine which will be efficient in single doses.

This work is described in Appendix II.

Piroplasmosis.

(a) Horses.

Twelve cases of equine piroplasmosis have been diagnosed; nine of these were due to *piroplasma caballi*, and three to *nutallia equi*.

The treatment with Quinine Hydrobromide administered intravenously has been continued with good results.

(b) Cattle.

Fifteen cases of bovine piroplasmosis have been diagnosed at the Laboratory, in addition to the cases diagnosed during the experiments on rinderpest and contagious bovine pleuro-pneumonia.

All were due to *Theileria mutans*.

It appears that this infection is widely spread in the Sudan, but does not cause any serious trouble amongst the native cattle.

It causes a dangerous disease in imported cattle and should be carefully watched for in these animals.

Personnel.

Captain F. J. Andrews, B.Sc., the Assistant Veterinary Research Officer, returned to the field staff.

His place was taken by Mr. S. C. J. Bennett, B.Sc., who arrived in Khartoum on September 19th, 1925.

Mr. P. A. C. Kenny, the Laboratory Assistant, has carried out his duties in a very satisfactory manner.

Mohammed Hassan, the head Laboratory Attendant has continued to give every satisfaction in his work.

In conclusion, I wish to thank Major R. G. Archibald, the Director of the Wellcome Tropical Research Laboratories, for the assistance given during the year.

I have the honour to be,

SIR,

Your obedient servant,

R. H. KNOWLES, *Major, R. A. V. C.,*
Veterinary Research Officer, Sudan Government.

APPENDIX I.

SUMMARY OF THE INVESTIGATIONS OF TRYPANOSOMIASIS OF CAMELS.

The experiments on the diagnosis and treatment of trypanosomiasis of camels have been continued. Very satisfactory results have been obtained in the treatment of this widespread disease and I consider the finding of a practical cure of this disease to be the most important step forward in disease control which has been made by this Department.

Treatment.

The promising results obtained last year at the Research Laboratory on the treatment of Trypanosomiasis of camels with Bayer 205, reported in Appendix II, Annual Report, 1924, have been verified by more extensive investigations under field conditions.

I was able to obtain a further supply of Bayer 205, free of charge, from Germany.

Bayer 205 for veterinary use is now known as Naganol.

In my previous report I recorded that six camels treated with Naganol were cured of the disease, three of these were treated with 10 grammes and the others with larger doses.

During the year under review 18 camels of No. 5 Coy. Camel Corps at Wad Medani were subjected to the treatment.

Twelve of these received 10 grammes of Naganol as a single injection, and six were treated with smaller doses.

In addition 5 camels have been treated with a single injection of 10 grammes of Naganol at the Research Laboratory.

The Naganol was given intravenously in 10 per cent. aqueous solution. All the camels were diagnosed microscopically and by the Formol-Gel test before treatment, and the results controlled by microscopic examination, Formol-Gel test, and by noting the condition of the animals, at varying periods, after treatment. The camels were branded with "T" on the left shoulder and "B" on the right shoulder.

A total of 17 camels have now been treated with a single dose of 10 grammes of Naganol, as shown in Table I.

TABLE I.
LIST OF 17 CAMELS TREATED WITH 10 GRAMMES OF NAGANOL.

Number.	Period since treatment.	Condition.		REMARKS
		Time of treatment.	Last observation.	
1559	11 months.	Poor.	Good.	All treated at Wad Medani. Since transferred to Bara. One month after treatment blood examined for 5 consecutive days. Five months after treatment blood examined for 10 consecutive days. Nine months after treatment blood examined for 5 consecutive days. Trypanosomes were not present in the blood of any. All were positive to the Formol-Gel test before treatment, and all were negative to the Formol-Gel test after treatment.
1459	"	Fair.	Very good.	
1499	"	Poor.	Very good.	
1563	"	Fair.	Good.	
1519	"	Poor.	Good.	
1593	"	Fair.	Good.	
1388	"	Poor.	Very good.	
1424	"	Poor.	Good.	
1571	"	Poor.	Very good.	
1585	"	Poor.	Good.	
1583	"	Poor.	Very good.	
1526	"	Poor.	Good.	
1524	6 months.	Poor.	Good.	Carried out at the Research Laboratory, Khartoum. Before treatment all were positive to microscopic, biological test on gerbils, and to the Formol-Gel test. After treatment blood examination was carried out for 3 months. Trypanosomes were not present in the blood. They were negative to the Formol-Gel test and biological test on gerbils after the period stated in the second column.
30	"	Good.	Very good.	
251	"	Very poor.	Good.	
45	"	Fair.	Good.	
863	"	Fair.	Very good.	

TABLE 2.

LIST OF CAMELS TREATED WITH SINGLE SMALLER DOSES OF NAGANOL.

Number.	Amount of Naganol.	Period since treatment.	Condition.		REMARKS.
			Time of treatment.	Last observation.	
1569	5 grammes.	10 months.	Poor.	Good.	All treated at Wad Medani. Since transferred to Bara.
1534	5 "	"	Poor.	Fair.	One month after treatment blood examined 3 alternate days.
1513	6 "	"	Fair.	Destroyed.	Four months after treatment blood examined 10 consecutive days.
1552	6 "	"	Fair.	Good.	Eight months after treatment blood examined 5 consecutive days.
1611	8 "	"	Poor.	Good.	Trypanosomes were not present in the blood.
1542	8 "	"	Fair.	Very good.	All were positive to the Formol-Gel test before treatment and except 1611, all negative after treatment. No. 1513 was destroyed for a fractured leg. It was in good condition at time of death.

The two camels on Table 3 show the result of treatment with a smaller preliminary dose of Naganol.

TABLE 3.

Number.	Date of treatment.	Amount of Naganol.	Period since last treatment.	Condition.		REMARKS.
				Time of treatment.	Last observation.	
1	29.12.24. 18. 3.25.	6 grammes. 10 "	} 8 months.	Very poor.	Fair.	Trypanosomes reappeared 11 weeks after first dose and remained free 8 months after second dose and blood remained negative to the Formol-Gel test.
277	2.12.24. 24. 1.25. 29. 3.25.	8 grammes. 10 " 10 "	} 5 months.	Poor.	Good.	Trypanosomes reappeared in blood 52 days after first dose and 36 days after second dose. The blood remained free for 5 months after the third dose when the camel was discharged fit for duty, and the blood remained negative to the Formol-Gel test.

As a control to the treated camels, 12 camels, diagnosed microscopically and by the Formol-Gel test at the same date that the camels in Tables 1 and 2 were treated at Wad Medani, were left untreated, and kept under observation. Four of these died or were destroyed for debility and the observations of the remaining 8 are shown in Table 4.

TABLE 4.
OBSERVATIONS ON THE 8 REMAINING UNTREATED CAMELS.

Number.	Period under observation.	Condition.		REMARKS.
		First observation.	Last observation.	
1613	11 months.	Fair.	Poor.	All at Wad Medani. Afterwards transferred to Bara. Nine months after the original diagnosis, the blood was examined microscopically, for 5 consecutive days. Trypanosomes were present in four of these (1613, 1614 1538 and 1566). All were positive to the Formol-Gel test at the time of diagnosis and all except one (1594) were still positive at the final observation.
1614	"	Fair.	Poor.	
1594	"	Poor.	Poor.	
1573	"	Good.	Fair.	
1539	"	Poor.	Good.	
1527	"	Poor.	Very poor.	
1538	"	Poor.	Fair.	
1566	"	Good.	Poor.	

REVIEW OF THE RESULTS OBTAINED AS SHOWN IN THE PRECEDING TABLES.

CONDITION OF THE ANIMALS.

The crucial test of the efficacy of any treatment in domestic animals is whether the animals treated return to good working, or economic condition.

Condition.

Table 1.—This shows that all animals treated with a single dose of 10 grammes of Naganol have returned to good working condition. Before treatment ten of the seventeen were in poor condition and unfit for work, and were selected as the poorest camels in order to act as a severe test of the treatment.

The camels received no special attention from the remainder of the Company except that they were allowed 48 hours rest after the treatment.

Table 2.—Shows that six camels treated with smaller doses of Naganol than 10 grammes also returned to good working condition and were apparently cured.

Table 3.—Shows, however, that in the case of two camels a cure was not effected by smaller initial doses of Naganol, and in the case of No. 277 three doses of Naganol were required to effect a cure.

It is probable that in some cases treated by smaller doses than 10 grammes of Naganol, the trypanosomes become resistant or develop a tolerance to the drug.

This suggests that in the treatment of trypanosomiasis one should aim at the destruction of the trypanosomes before such tolerance is developed, the ideal being treatment by a single dose.

The possibility of producing a strain of trypanosome tolerant to Naganol, and such a strain being transmitted to other camels, must be borne in mind.

Table 4.—Shows that of the untreated camels (eight out of twelve survived) only one had returned to good condition, whereas five had become in worse condition and four had died or been destroyed.

Microscopic Examination.

Table 1 shows that all cases showed trypanosomes in their blood before treatment, but after a single dose of 10 grammes of Naganol trypanosomes were never present although repeated blood examinations were made.

Tables 2 and 3 show that although treatment with smaller doses may cause the disappearance of the trypanosomes (*Table 2*) it will not do this in all cases (Nos. 1 and 277).

Table 4 shows that four out of eight of the untreated camels showed trypanosomes in the blood.

These were only examined for five consecutive days, and knowing the intermittency of the presence of trypanosomes in the blood one can suppose that the others would show trypanosomes if examined long enough.

The evidence thus obtained presents conclusive proof as to the efficacy of the treatment of camels affected with trypanosomiasis in the Sudan by a single intravenous injection of 10 grammes of Naganol in a 10 per cent. aqueous solution.

DIAGNOSIS.

In Appendices 1 and 2 of my Annual Report last year, I recorded observations on the Formol-Gel test as a method of diagnosis of trypanosomiasis of camels.

The observations showed that the sera of seven camels affected with trypanosomiasis all gave positive reactions, whereas the sera of twelve healthy camels all gave negative results.

The test has been applied on a more extensive scale to test the reliability, or otherwise, of this method of diagnosis in the field.

All the camels of No. 5 Company, Camel Corps, at Wad Medani were tested and the results are shown in Table 5.

TABLE 5.

Date.	Total tested	Reactors.	Non-reactors.	Cam ls showing reactors.	Trypano-somes Non-reactors.
6-11-24) to 14-12-24)	162	124	38	47 (a).	2
6- 2-25	75 (c).	59	16	(b) 10.	0

(a) Four blood examinations at irregular intervals.

(b) Single blood examination.

(c) Camels which reacted to first test but had not shown trypanosomes in their blood.

Reference to Table 5 shows that of 108 (124 less 16) permanent reactors, in 57 (52.7 per cent.) trypanosomes were found in the blood microscopically by repeated blood examinations.

Reference to the two non-reactors showing trypanosomes in their blood will be made later.

Test on Healthy Camels.

The Formol-Gel test was applied to 160 remount camels brought from a trypanosome free area in the Northern Sudan; of these 9 reacted to the test. They were re-tested 5 weeks after and all were negative. This is called a temporary reaction.

Table 5 shows that of the camels tested at Medani, 16 out of 162 camels had a temporary reaction. These, together with the 9 out of 160 remount camels, made a total of 25 temporary reactors out of 322 camels, that is, a temporary reaction or error of the test in 8 per cent. of cases.

RELATION BETWEEN TRYPANOSOMIASIS OF CAMELS AND A REACTION TO THE FORMOL-GEL TEST.

(a) Loss of the reaction to the Formol-Gel test after treatment with Naganol.

The sera of all 17 camels shown in *Table 1* and treated with 10 grammes of Naganol were all positive before treatment, and all negative 2 months after treatment.

In the case of the camels in *Table 2* treated with smaller doses, the reaction to the test disappeared in all except one, *e.g.*, 1611.

In the two camels 1 and 277 (*Table 4*) the reaction was lost after each dose, but reappeared with the appearance of trypanosomes, finally disappearing in both cases after the last dose.

(b) Development of the reaction to the Formol-Gel test of the sera of camels after infection with trypanosomiasis.

Three healthy camels, as shown in *Table 6*, were experimentally infected by subcutaneous inoculation with 2 c.c. citrated blood from a natural case of acute trypanosomiasis.

These camels were tested by the Formol-Gel test twice before infection, and every four days after infection.

Before infection they were negative to the Formol-Gel test, microscopically, and to the biological test on gerbils.

Camels Nos. 49 and 75 were normal camels which had not previously had trypanosomiasis, whereas camel No. 1052 was previously a natural case of trypanosomiasis cured with Naganol 10 months before the recent infection.

TABLE 6.

Number.	Date of infection.	Period for trypanosomes to appear in blood.	Period for development of Formol-Gel reaction.	Course of the Disease.
49	13.11.24.	8 days.	5 weeks.	{ Developed acute Trypanosomiasis. Rapid loss of condition. Continuous fever. Destroyed in extremis. Trypanosomes very numerous.
75	"	7 "	6 "	
1052	13.11.24.	23 days.	7 weeks.	{ Few trypanosomes. No fever. Remained in good condition and was destroyed 3 months after in good condition.

Reference to Table 6 shows that in camels 49 and 75 a positive reaction to the Formol-Gel test developed after 5 and 6 weeks respectively, whereas in camel 1052, cured of the disease, the reaction to the Formol-Gel test developed after 7 weeks.

Under this heading reference will be made to the two camels (1569 and 1474) shown in Table 5 which, although negative to the Formol-Gel test, showed trypanosomes in their blood.

No. 1569 was treated with Naganol on 13.1.25, and 1474 was not treated. Three and a half months afterwards both were subjected to the Formol-Gel test. The untreated one had by this time developed a positive reaction to the Formol-Gel test whereas the treated camel was still negative.

The question arises as to whether all camels suffering from Trypanosomiasis react to the Formol-Gel test.

Seventy-seven camels diagnosed microscopically as Trypanosomiasis were tested, and 75 of these reacted.

The two exceptions were 1569 and 1474 referred to above. In conjunction with the evidence obtained in Table 6 we can conclude that these two were recent infections and that the power to react had not had time to develop.

Immunity.

The question which presents itself very readily is whether a camel, having suffered from Trypanosomiasis and been cured by Naganol, has an immunity against re-infection. The question is one of importance.

If the Naganol only cures the camel of trypanosomiasis and does not leave any immunity it is comparable with having a new healthy camel, but if on the other hand the camel is cured and is also immune against the disease we have a camel much more valuable than a camel that has never suffered from the disease.

It is known that as a rule if an animal recovers from trypanosomiasis it has a certain degree of immunity. This immunity is very specific, and only for the species of trypanosome from which the animal suffered.

The re-infection experiment on camel 1052, and shown in Table 6, was carried out to ascertain if any immunity was present against the disease after cure.

Two camels free from trypanosomiasis were used as controls. It will be seen that the appearance of trypanosomes in the blood was delayed up to 23 days in the case of camel 1052, whereas in the control camels trypanosomes appeared in the blood in 8 and 7 days.

Although the trypanosomes appeared in the blood of camel 1052, no symptoms of the disease were present. The trypanosomes were scanty, only intermittently present, and the animal remained in good condition for three months, when it was destroyed still in good condition.

Compared with this the two control camels, 49 and 75, developed a per-acute attack of trypanosomiasis.

Trypanosomes were very numerous in the blood and constantly present. There was a continuous high temperature, and a rapid loss of condition resulting in emaciation, and the animals were destroyed in extremis six weeks after infection.

From this preliminary experiment it would appear that immunity is acquired in camels cured of the disease.

It must be noted that the experimental infection in this case was very severe, *i.e.*, 2 c.c. of blood containing large numbers of trypanosomes from a natural case, and this accounts for the severe infection of the controls, at the same time making the test on the cured camel also very severe. It will be noticed that the cure of the camel was effected eleven months before this immunity experiment was carried out.

I intend to carry out further investigations on this interesting subject.

WHAT PERCENTAGE OF LOSSES OF CAMELS IS DUE TO TRYPANOSOMIASIS.

During the years 1922 to 1924 inclusive the total losses of camels in the Egyptian Army was 1292, and out of these, 508 or 39 per cent. were diagnosed as trypanosomiasis.

Reference has already been made (Annual Report, 1924) to the difficulty of diagnosis in Trypanosomiasis, and so it is difficult to get reliable statistics as to the actual losses from this disease, but it is generally thought from practical experience that either directly, or indirectly, the percentage of losses from trypanosomiasis in the Sudan is very high, probably up to 90 per cent. in some districts.

In support of this hypothesis is the fact that of animals treated with 10 grammes of Naganol, 100 per cent. have not only lived but have returned to good working condition.

CONCLUSIONS.

- (1) Naganol, as a single dose of 10 grammes administered intravenously in 10 per cent. aqueous solution, is a specific in the treatment of camels affected with *Trypanosoma Soudanense*.
- (2) The Formol-Gel test, although giving 8 per cent. of reactions in healthy camels, is of practical value in the diagnosis of trypanosomiasis of camels.

R. H. KNOWLES, *Major, R. A. V.C.*,
Veterinary Research Officer, Sudan Government.

APPENDIX II.

EXPERIMENTS ON CONTAGIOUS BOVINE PLEURO-PNEUMONIA AT THE VETERINARY RESEARCH LABORATORY.

The experiments carried out on Contagious Bovine Pleuro-pneumonia have had as an objective the production of a prophylactic vaccine made from the virus of the disease artificially cultivated in the laboratory.

This included :—

- (i) Isolation and cultivation of the strains of the virus of Contagious Bovine Pleuro-pneumonia.
- (ii) Attenuation of the strains of the virus by continuous sub-culturing.
- (iii) Estimation of the virulence of the strains.
- (iv) Estimation of the antigenic or immunity-producing properties of the strain.

Isolation and Cultivation.

The method of isolation and cultivation of the strains of the virus followed fairly closely that used at the Veterinary Research Laboratory of Kenya, which I had the opportunity of studying during my visit there. It was found, however, that filtration of the seed material or of the culture media was unnecessary, and no filtration is carried out in the technique employed. The virus is cultivated in equal parts of bouillon-martin and meat infusion with 10 per cent. ox serum added.

The reaction of the medium is P.H, 8.0.

Cultures were obtained :—

- (a) By sowing the medium with lymph from a tumour produced by the subcutaneous inoculation of calves with lymph from the lungs or pleura of a natural case of Contagious Bovine Pleuro-pneumonia.
- (b) By sowing lymph from a natural case direct into the medium.
- (c) By mixing lymph from the lungs of a natural case of Contagious Bovine Pleuro-pneumonia with glycerine, allowing it to stand for some hours, and then sow direct into the culture medium.

Six strains of the virus have been isolated.

Attenuation of the Virus.

This is normally attained by sub-cultivation, and it has been said that after several sub-cultivations the virulence becomes fixed. It appears, however, from these experiments that the lowering of the virulence progresses with continued sub-cultivation. It may be necessary to isolate new strains of the virus from time to time for vaccine production.

Virulency Tests.

These are carried out by subcutaneous inoculation of four different strains of the virus. Some were done about 6 inches from the tip of the tail, and others behind the shoulder.

Reference to the Tables show that the maximum reaction produced was moderate (††). These reactions soon subsided and no harmful effects were produced.

Temperatures were recorded during the tests.

The thermal reactions were also slight.

Vaccinations.

These vaccinations were, at the beginning, the virulency tests.

Most of the vaccinations were done according to the technique used in Kenya, *i.e.*, the first dose of vaccine was given into the tail, and the second dose of the vaccine behind the shoulder. After varying intervals, the immunity produced by the vaccine was tested.

Immunity Tests.

The immunity produced by the vaccines was then tested by the subcutaneous inoculation of :—

- (a) Natural virus, represented by the lymph from the lung or pleura of a natural case of Contagious Bovine Pleuropneumonia.
- (b) Tumour virus, *i.e.*, lymph from a tumour produced by the subcutaneous inoculation of natural virus.

In all the immunity tests a control was used, *i.e.*, a non-vaccinated calf was inoculated with the test virus to prove its potency.

TABLES.

The following Tables show the results obtained from vaccination, and the immunity tests of four groups of bulls.

Different strains and different combinations of strains of vaccines are used.

The animals are grouped in the Tables according to the virulent material used in the immunity tests.

The doses of vaccine employed were :—

Tail vaccine	...	...	...	...	$\frac{1}{2}$ c.c.
Shoulder vaccine	...	...	...	...	1 c.c.
Virulent material in immunity tests	...	...	...	...	2 c.c.

The reactions are recorded by the following signs :—

No reaction	...	...	...	...	—
Slight reaction	...	...	...	...	+
Moderate reaction	...	...	...	...	++
Severe reaction	...	...	...	...	+++
Very severe reaction	...	...	...	...	++++

Records of temperatures were kept but are not included in this report. The thermal reactions from the vaccine were, in all cases, slight.

GROUP 1.

The virus used in the immunity test in this Group was lymph from a natural case of Contagious Bovine Pleuro-pneumonia.

No. of Bull.	Date of First vaccine.	Strain and Sub-culture.	Position.	Reaction.	Date of Second vaccine.	Strain and Sub-culture.	Position.	Reaction.	Immunity Tests.	
									Virus.	Reaction.
31	18.12.25.	7th (ii).	Tail.	+	19.1.25.	11th (ii).	Shoulder.	—	Subcutaneous inoculation of lymph from natural case (IV) of C.B.P.P. on 3.2.25.	+
32	"	7th (I).	"	+	"	11th (i).	"	+		+
23	"	7th (i).	"	++	"	12th (iii).	"	—		+
25	"	8th (iii).	"	+	"	11th (I).	"	—		+
34	Control.	Not vaccinated.								++++

In the four vaccinated animals the swellings were small, a maximum of 3" x 3" and had disappeared by the fifteenth day.

In the case of the non-vaccinated bull (No. 34) there was a large œdematous swelling extending from the left side into axilla and on to the brisket. On the thirteenth day the animal had difficulty in rising, temperature 105° F. and was destroyed.

Post-mortem revealed extensive œdematous swellings, the lymph from which was inoculated into the bulls in Group 2.

GROUP 2.

The virus used in the immunity test in this group was lymph from the tumour of Calf 34 of Group 1.

No. of Bull.	Date of First vaccine.	Strain and Sub-culture.	Position.	Reaction.	Date of Second vaccine.	Strain and Sub-culture.	Position.	Reaction.	Immunity Tests.	
									Virus.	Reaction.
7	18.12.24.	7th (i).	Tail.	+	19.1.25.	11th 1.	Shoulder.	+	Subcutaneous in- oculation of lymph from calf 34 on 17.2.25.	+
21	"	7th (i).	"	+	"	12th (iii).	"	—		+
22	"	7th (ii).	"	++	"	11th 1.	"	+		+
33	"	7th (ii).	"	++	Nil.			—		—
35	Control.	Not vaccinated.								+++++

The same remarks as those in Group 1 apply to this Group, except that the control, No. 35, was killed on the sixteenth day.

GROUP 3.

The virus used in the immunity test on this Group was lymph from the tumour of Calf 34.

No. of Bull.	Date of First vaccine.	Strain and Sub-culture.	Position.	Reaction.	Date of Second vaccine.	Strain and Sub-culture.	Position.	Reaction.	Immunity Tests.	
									Virus.	Reaction.
24	18.12.24.	7th (ii).	Tail.	+	19.1.25.	11th (ii).	Shoulder.	+	Subcutaneous inoculation of tumour virus from calf 35 on 4.3.25.	+
26	"	7th (ii).	"	++	"	11th (i).	"	-		+
6	"	8th (iii).	"	+++	"	12th (iii).	"	+		+
13	"	7th (iii).	Shoulder.	+++	"					+
37	Control.	Not vaccinated.		+++						+++

The same remarks apply as those of Group 1, except that the control died on the seventeenth day.

GROUP 4.

The virus used in the immunity test on this Group was lymph from the tumour of Calf 37.

No. of Bull.	Date of First vaccine.	Strain and Sub-culture.	Position.	Reaction.	Date of Second vaccine.	Strain and Sub-culture.	Position.	Reaction.	Immunity Tests.	
									Virus.	Reaction.
36	2.3.25.	2nd IV.	Shoulder.	++	Nil.	—	—	—	Sub-cutaneous inoculation of tumour virus from Calf 37 on 21.3.25.	+
38	Control.	Not vaccinated.		.	—	—	—	—		+++

The control, No. 39, died on the seventeenth day, with a very extensive œdematous swelling extending over the shoulder and down into the axilla and into forearm.

RESULTS.

Reference to the Tables shows that :—

- (i) The maximum reactions obtained from the vaccines were moderate.
- (ii) All vaccinated animals had a strong immunity against subcutaneous inoculation of virulent lymph.
- (iii) The virulency of the lymph used in each Group was proved to be high by the production of a very severe reaction in non-vaccinated animals, two of which (37 and 38) died. The other two controls were killed when a severe reaction had occurred in order to obtain lymph for inoculation.
- (iv) Three bulls (33, 13 and 36) which received a single vaccine into the shoulder also developed a strong immunity.

The programme for further work on this subject includes :—

- (1) Estimation of the relation between the virulency of the vaccine and its antigenic properties.
- (2) The possibility of using non-virulent strains in larger doses, and the use of a single vaccine to replace the double vaccine.
- (3) The duration of the immunity conferred by the different methods of vaccination.



